Synopsis

Ph.D. in Food Service Management and Dietetics

COMPUTATION OF NUTRITIONAL FOOTPRINT OF FOOD CONSUMED BY SELECTED SUBJECTS AND CREATING AWARENESS ON PLANETARY HEALTH DIET USING THE DEVELOPED e APPLICATION

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Introduction

Sims (2011) highlighted that around 30 percent of global energy usage accounts for food systems. In addition to the significant amount of energy required to activate all the links in the food chain, food systems contribute to one-third of human greenhouse gas emissions (GHG), including carbon dioxide (CO_2) (Smith *et al*., 2014). Agriculture contributes significantly to non-CO_2 emissions, accounting for 57 percent of the total anthropogenic emissions globally and 90 percent of NO_2 (Saunois *et al.,* 2016). Unhealthy diets affect the environment adversely. High levels of milk, meat, fish and other seafood, nuts and dry fruits might be a nutritious diet but cannot be eco-friendly (Garnett, 2016).

Global Panel (2015) suggests that to reduce greenhouse gas emissions from food, there is an urgent need to transition from the current system to a more sustainable one. To respond to these crucial needs, the EAT-Lancet Commission convened the global scientist targets for healthy diets and sustainable food production of 37 leading scientists from 16 countries, in various disciplines including human health, agriculture, political science and environmental sustainability (EAT-Lancet Commission report, 2019).

EAT-Lancets presented a healthy and sustainable model diet that seeks to sustain the health of the population and the environment, which is known as the 'Planetary Health Diet.' For sustainable food systems and health diets, the guidelines are based mainly on the quantity and quality intake, and lower consumption of meat, fish, eggs, refined cereals whereas it recommends more vegetables, greens, fruit and whole grains (Willet *et al.,*2019).

According to the EAT-Lancet Commission report, (2019), the planetary diet for health is a global diet that symbolizes a half- platform of fruits and vegetables, nuts, while the other half is primarily made from whole grains, proteins from plants, unsaturated vegetable oils, low lean meat and milk content and a minimum of added sugar and starchy vegetables.

Planetary diets are generally higher in dietary fibre, magnesium, folic acid, vitamins C and E, iron and phytochemicals, and they tend to be lower in calories, saturated fat and cholesterol, omega-3 fatty acids, vitamin D, calcium, zinc, and vitamin B-12 (Davey *et*

*al.,*2003). A planetary diet is helpful to increase vitamins and phytochemical consumption and minimize the intake of dietary components that cause many chronic illnesses (Dewell *et al.,*2008).

Hence the study was proposed with a primary objective to improve the nutritional footprint by promoting a planetary diet and the secondary objectives were,

- To analyse the knowledge, attitude and practice of planetary health diet among selected subjects
- To calculate the carbon and nutritional footprint of the food consumed by selected subjects.
- To develop and evaluate an e-application in promoting a planetary health diet.
- To create awareness on the importance of planetary health diet and analysing the post–knowledge of planetary health diet among selected subjects

Methodology

Phase I - Analyzing the knowledge, attitude and practice of planetary health diet among selected subjects.

In Phase I, The places such as Periyanayakanpalayam, Saravanampatti, Madhukarai, Kinathukadavu, Vadavalli, Thondamuthur, Irugur and Somanur of Coimbatore district with easy commute from the university and also the places where agricultural production was higher were selected for the study.

Middle aged adults within the age group of 30-50 years were selected using purposive random sampling method and based on their willingness to participate in the study. By using the formula by Slovin., (1960), the sample size had arrived as 400.

An orientation was given to the selected subjects regarding the conduct of the study. The informed consent form was developed in both English and regional language (Tamil) to take care of both urban and rural areas. The consent was obtained from the subjects to confirm their voluntary willingness to participate in the study. The study protocol was approved by the Institutional Human Ethical Committee of Avinashilingam Institute for Home Science and Higher Education for Women (AUW/IHEC/FSMD-21-22/XPD-27).

An interview schedule was prepared in English. Data regarding their demographic profile, socio economic status, food expenses, health status of the subjects and their family members, anthropometric details and diet pattern. And also, food and nutrition related knowledge, sociocultural reasons on diet, psychopathology of planetary health diet, availability, knowledge, attitude towards planetary health diet and furthermore health and wellness tool, eating behaviour, diet diversity, food frequency and 24-hour recall was collected through developed interview schedule.

Phase: II Calculation of Carbon and Nutritional Footprint of the food consumed by the selected subjects

Market survey was done to collect data on place of procurement of food ingredients. Data on sourcing pattern of perishable food and non-perishable food were collected from three large distributors for each category in Coimbatore.

The data regarding the places where food ingredients are received for sales were collected and by using that data, the distance from that place to Coimbatore was estimated and data about the mode of transport and irrigation methods such as fertiliser used, watering methods, harvesting methods, mode of vehicles used during the process and total yield of food per acre were collected as secondary data.

From these collected data, emission factor of transport and irrigation was calculated. Emission factor of all food ingredients was calculated by adding irrigation and transport emission factor of food ingredients. These obtained emission factors were applied in the carbon footprint formula.

The carbon footprint and nutritional footprint was calculated using the formula given by Ministry of Environment, Forest and Climate Change (2009). The nutritional footprint was calculated by using qualifying index, disqualifying index and nutrient balance score depending on the food consumed by the subjects.

Phase III- Development and Evaluation of an e-application in promoting planetary health diet.

The developed e-application was planned to be designed and developed in four parts. Through first part, the awareness on planetary Health Diet was given. This part consists of

data on sustainable Planetary Health diets and its importance towards maintaining ecological balance.

The carbon footprint of each commonly used food ingredient was calculated in the e-application. When the user enters their 24-hour food consumption with raw ingredients in quantity, their equivalent nutrient consumption will be arrived. This is considered as actual intake which was compared with the RDA for respective age and the individual's excess, or deficit consumption had arrived. Along with that Qualifying Index, Disqualifying Index, and Nutrient Balance score were also calculated using the respective formulae.

The other part consists of carbon footprint food exchange list to reduce the carbon footprint of food according to the required nutrients such as energy, carbohydrates, protein, fat, fibre, vitamins and minerals.

The developed e-application was shared with the dieticians, computer professionals and the public for evaluation. It was evaluated in terms of content, usefulness, and time consumption. The interview schedule was given to the subjects to evaluate the developed e-application. Based on their inputs, the e-application was further updated for useful additional information.

Phase IV - Creating awareness on the importance of planetary health diet and analyzing the Post awareness – knowledge of planetary health diet among selected subjects.

A survey was conducted before awareness sessions to assess the Knowledge, attitude and practice of the planetary health diet in Phase I. The data was collected from the selected subjects using an interview schedule. The awareness given contained information regarding planetary health diet using the e-application developed which was also interactive. The developed e-application was shared free of cost and the subjects were requested to install for their future use.

After the awareness session, again the survey was conducted among the selected subjects to check the effectiveness of the awareness program. Post awareness knowledge of the subjects was accessed and also their willingness to follow planetary health diet was also recorded. Pre and post knowledge, attitude and practice of planetary health diet were compared. The collected data were analysed using SPSS software.

Results and Discussions

Phase I - Analyzing the knowledge, attitude, and practice of planetary health diet among selected subjects.

- The data was collected to analyse the knowledge, attitude and practice of planetary health diet among selected women in Coimbatore and the results are shown.
- Majority of the selected women were in the age group of 46- 50 years followed by the age group 41 – 45 years. More than half of the subjects were Hindus, followed by Muslims and Christians. Nearly 93% of the subjects were from nuclear family and only remaining 7% of them belonged to joint family. 99 percent of the subjects were literate whereas about 28 percent of the subjects had completed their undergraduate degree.
- It is clear that 36% of the subjects belonged to lower middle class followed by upper middle class at 32%. Only 8 percent of the subjects belonged to upper class.
- Three hundred fifty-seven subjects follow flexitarian diet and only very few subjects follow non-vegetarian (10), vegetarian (11), lacto vegetarian (8), ova vegetarian (8) and lacto ova vegetarian (6) which was very much less.
- The selected subjects spent more than 1000 rupees per month on meat, and cereals based on the mean food costs of the subjects. They don't spend much money on spices and ready-to-cook items. Even if consumed daily, they spent less on low-priced vegetables that cost them Rs. 425 (per month).
- The significant negative relationship between diet pattern and Body Mass Index of the subjects of about 27 percent indicates that individuals who adhere to a flexitarian diet have a much higher likelihood of experiencing overweight and obesity. Two of the 11 subjects who followed a vegetarian diet were classified as underweight, while four fell within the normal BMI range.
- A significant negative relationship between dietary patterns and waist-hip ratio implies that individuals who adhere to a flexitarian diet tend to have a higher prevalence of obesity compared to those who embrace alternative dietary approaches.
- An important finding on the relationship between knowledge about the planetary health diet and attitudes towards it. It indicates a significant negative correlation of 62%, suggesting that while the subjects were aware of the planetary health diet, they did not adhere to it in their own dietary choices. This demonstrates a discrepancy between knowledge and practice concerning the planetary health diet.

- A statistically significant negative relationship between the knowledge of the subjects and their adherence to the planetary health diet indicates that as the awareness about the diet increased, the practice of following the diet decreased. It was observed that many subjects who were aware of the numerous benefits associated with the planetary health diet were still unwilling to eliminate or reduce the consumption of meat and its products, as well as milk and its derivatives, eggs, fish, and processed foods from their daily intake.
- It was observed that subjects who scored above three on the survey consume meat daily, weekly, or fortnightly despite being aware of the negative impact of meat consumption on personal health and the environment. These findings suggest that there is reluctance among the subjects to eliminate meat from their diet, despite their awareness of its detrimental effects.
- Among the 33 individuals who do not consume meat, 17 of them exhibited a normal Body Mass Index. Conversely, those who consume meat every week, twice a week, or every two weeks were more susceptible to obesity.
- The data reveals that a significant majority of individuals who consume meat exhibit obese characteristics. At the same time, only a minimal proportion of non-meat eaters also fall into the obese category. This correlation could arise from various factors, such as genetic predisposition, high consumption of fatty foods, dairy products, fast food, processed foods, and underlying diseases and disorders.

Phase: II Calculation of Carbon and Nutritional Footprint of the food consumed by the selected subjects

- The energy intake of subjects belonging to the age group of 36-40 years (1957±17.32) was found to be higher compared to other age groups. Furthermore, the subjects in this age range also had a higher consumption of carbohydrates compared to RDA guidelines. On the other hand, the subjects in the age group of 46-50 years were observed to consume a lesser quantity of food, indicating that their intake of protein, fat, and fiber was inadequate. Additionally, it was noted that individuals in the age group of 30-35 years had a higher intake of protein and fiber than the RDA recommendations. None of the subjects consume adequate amounts of calcium, iron, beta carotene, folic acid and vitamin C when compared to RDA.
- The figure highlights that foods such as fruits, vegetables, spices, pulses and legumes are considered very good in terms of high QI as well as low DI. On the other hand, seafood, meats, milk, and its products also show high QI values but exhibit higher DI scores as well.

Moreover, foods that contain saturated animal fats, sugars, or sodium tend to have lower QI scores.

- Green leafy vegetables are one of the food groups with a significantly lower carbon footprint and cause least negative impact on the environment than other types of food. Following closely behind are vegetables and fruits, which also have relatively low environmental impact. On the contrary, meat and meat products as well as fish contribute substantially to carbon emissions and have a high carbon footprint. Cereals, although being an essential part of our diet, have a notably high impact on the environment by way of higher emissions.
- The Qualifying Index of the subjects was found to be higher during lunch compared to other meals. During breakfast, the qualifying index of individuals aged between 46 and 50 years was higher than other age groups. Similarly, during lunch, the qualifying index of subjects aged between 30 and 35 years was highest. Lastly, during dinner, the qualifying index of subjects aged between 30 and 35 was higher as well.
- The disqualifying index for breakfast was found to be lowest compared to other two meals. Additionally, when considering different age groups, the disqualifying index for the subjects in the 46-50 year age group was lower for breakfast, the 41-45 year age group exhibited a lower disqualifying index for lunch, and the same 41-45 year age group also displayed a lesser disqualifying index for dinner compared to other age groups.
- The breakfast meal consistently demonstrated a higher nutrient balance score than other two meals. Furthermore, individuals in the age group of 30-35 years had higher nutrient balance scores across all meals throughout the day.
- In the age group of 30-35 years, the subject had a highest qualifying index, indicating a favourable outcome. On the other hand, in the age group of 46-50 years, the subject had a lower disqualifying index. Additionally, the nutrient balance score of the subjects aged 30-35 years was higher compared to those in the other age groups, indicating that their diet was more balanced.
- The carbon footprint of breakfast was highest among individuals in the age group of 46-50 years, followed by those in the age group of 41-45 years. Additionally, when comparing the carbon footprints of the other two meals of the study subjects, it was noted that individuals aged 30-35 years had higher carbon footprints than the rest of the subjects.

- The carbon footprint of the study subjects in the 30-35 age groups was higher than all other age groups. Additionally, the 46-50 age groups had the lowest carbon footprint, followed by the 41-45 age groups.

Phase III - Development and Evaluation of an e-application to promote planetary health diet:

- The initial page of the website presents two options for users: "log in" or "sign in." For new users, the first step is to create an account by signing in with their email ID.
- Upon accessing the profile page, users are required to provide their personal details, including their name, age, gender, mobile number, and email address etc... Additionally, anthropometric measurements, such as height and weight, need to be provided for further calculations. These calculations include the determination of the Body Mass Index (BMI), for which the standards set by the Asian pacific calculation are displayed in a pop-up window. Furthermore, when users enter their waist and hip circumference measurements, the Waist-Hip Ratio (WHR) is calculated, with the corresponding standards also being displayed in a pop-up screen. Once all the necessary information has been entered, users can save their profile, which will then be stored with the provided details.
- In the interface, prominently displayed three-lined menu icon is in the upper left corner. A pop-up menu will appear by clicking on this icon, offering a range of options for the user. These options include the profile page, which allows users to customize and update their personal information, an incognito mode that ensures private usage, a detailed history section that stores calculations and data for up to two days, a language selection feature where users can choose between three user-friendly languages: Tamil, English, and Hindi, and finally, a sign-out option that can be utilized whenever the user wishes to log out of the application.

- This page serves as the primary interface featuring three distinct modules. The first module is an advanced calculator designed to assess both carbon and nutritional footprints of any type of food. The second module is dedicated to the planetary health diet, offering detailed information on sustainable dietary pattern; the third module is carbon footprint food exchange list.

- The carbon and nutritional footprint module, which is the first module, is composed of two menus that are mandatory for calculating the carbon and nutritional footprint.

- The first menu is the meal type menu, which offers seven options for different meal timings: early morning, breakfast, mid-morning, lunch, mid-evening, dinner, and bedtime. Users are required to select one of these options, which will then take them to the subsequent page where they need to choose the "add a food ingredient" menu.

- The food groups option has different types of food groups like cereals, grains and its products, pulses and legumes, leafy vegetables, other vegetables, roots and tubers, nuts and oil seeds, fruits, fishes and other sea foods, meat and poultry, milk and milk products, fats and edible oils, sugars and beverages in which anyone must be selected by the users.

- The next step is item choices, where one ingredient must be chosen from all the ingredients listed in the IFCT, 2017 book. The amount of that specific component should be explicitly entered into the app. On the screen, the chosen ingredients would show up. There are two choices marked "reset" and "calculate" at the bottom of that page. The reset menu allows you to undo and make modifications. Additionally, the user should choose calculate menu to get the result page.

- This would lead to a three-part result page, the first of which contains information on their daily nutrients determined. The reference RDA for 2018 would also be displayed alongside. The user would thus be able to easily comprehend if their food consumption were adequate or inadequate by being told whether their intake in surplus or deficit intake. The carbon calculator is the second section. According to the quantity of the specific component that the user specified, the outcome would be displayed. The third component of the outcome was nutritional footprint, which was computed using three calculators: the qualifying index, the disqualifying index, and the nutrient balance score.

- Planetary Health Diet was devised as a teaching tool in the second module. This module consists of PowerPoint presentation for ease of comprehension; these were provided with voiceovers in both English and the regional language (Tamil).

- The final element was food exchange list. When it is chosen, a page containing a list of foods that may be exchanged for others to lessen the carbon footprint of food according to the nutrients such as energy, carbohydrates, protein, fat, fibre, vitamins, and minerals is brought up. The user may choose food ingredients with minimal carbon footprint and healthy food from this website.

Evaluation of developed e-application

- A comprehensive overview of the demographic characteristics of the subjects involved in evaluating the newly developed e-application indicates that the majority of the subjects belonged to the age group of 25-30 years and was predominantly female. The sample comprised 10 computer professionals, 10 dietitians, and 10 household women.
- It was evident from the study that all the subjects utilized smartphones. Remarkably, none of the users encountered technical issues such as bugs or crashes while using the application. Moreover, dieticians and household women expressed their intention to continue using this e-application and even recommended it to others. Although a few respondents found the app slightly time-consuming, all subjects unanimously agreed that the fonts used in the interface were legible and easy to comprehend.
- This table effectively demonstrates that the application fulfils the requirements for all subjects, allowing them to confidently calculate their Body Mass Index (BMI) and Waist-to-Hip Ratio (WHR) using the app. The dietician expressed satisfaction with the app's data, making it comprehensible and user-friendly. The app's user interface was also considered intuitive and easily navigable. Overall, the data presented in the table confirms that the app is highly efficient in meeting their needs.
- Based on the feedback received, it was evident that the app was perceived as informative and beneficial by all the subjects. The aspects of task performance, app responsiveness, screen design, and content relevance were positively evaluated by the dietitians.

Phase IV - Creating awareness on the importance of planetary health diet and analyzing the Post awareness – knowledge of planetary health diet among selected subjects.

- It was clear from the results that there was significant difference between pre and post food and nutrition related knowledge of selected women which means that after being provided with awareness, the women subjects experienced a noticeable improvement in their understanding and knowledge of food and nutrition.
- There was a significant difference between pre and post Socio cultural reasons on diet of selected women. This disparity suggests that before giving awareness, women followed to dietary practices followed by their family and friends, regardless of their health status. However, post-awareness, these women displayed a heightened sense of self-awareness and made dietary choices based on their individual preferences and health conditions.

- There was a significant difference between pre and post psychopathology of planetary health diet which means Initially, many subjects believed that adhering to a planetary health diet was challenging and hence lacked the necessary nutrients, resulting in nutrient deficiencies and related issues. However, after awareness session, they began to realize that the planetary health diet was indeed beneficial for both their personal well-being and environmental health.
- The understanding and awareness of women regarding the planetary health diet improved post awareness leading to an increase in their knowledge of the planetary health diet.
- The findings indicate that there is no significant difference between the implementation of a planetary health diet before and after the awareness program. This implies that while the subjects are cognizant of the significance of a planetary health diet, they fail to put it into practice even after receiving the necessary information and guidance.
- There is no significant difference between pre and post awareness meat consumption. Despite being aware of the environmental and personal impact of meat consumption, individuals have not made efforts to limit or restrict their intake of meat in their diet.
- It was evident that there existed an adverse relationship between post-knowledge and attitude, as well as meat consumption. This implies that despite increasing knowledge, there was no corresponding change in individuals' attitudes towards embracing a planetary health diet, nor did it affect their meat consumption habits.

Conclusion

The planetary health diet is a holistic approach to nutrition that not only promotes human health but also aims to safeguard the well-being of the planet. The planetary health diet is a dietary framework that focuses on promoting both human health and environmental sustainability. The goal of the planetary health diet is to improve global health outcomes and reduce the strain on the planet's resources, addressing issues such as climate change, deforestation, and loss of biodiversity. It emphasizes a more sustainable and balanced approach to nutrition that not only benefits individuals but also contributes to the well-being of the entire planet. This diet is designed to promote human health by reducing the risk of chronic diseases such as heart disease, diabetes, and obesity. The planetary health diet is adaptable to different cultural and regional preferences, allowing for a wide range of food choices. It recognizes that local contexts and traditions play a significant role in dietary patterns. Achieving the goals of the planetary health diet requires collaboration on a global

scale. Governments, food industries and individuals must work together to transform food systems, reduce food waste, and promote sustainability. Embracing the principles of the planetary health diet can lead to long-term positive effects on both human health and the environment.

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